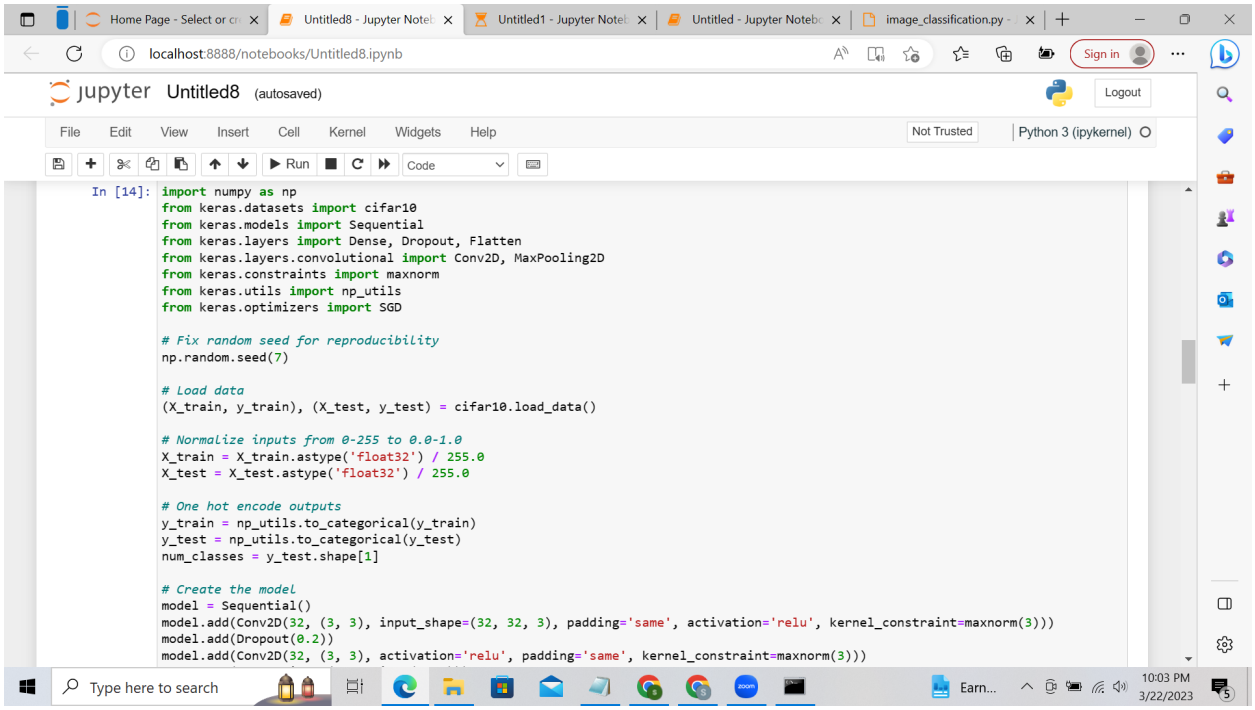
Assignment - 7
Deep Learning Image Classification with CNN

1. Follow the instruction below and then report how the performance changed.(apply all at once)
   - Convolutional input layer, 32 feature maps with a size of 3×3 and a rectifier activation function.
   - Dropout layer at 20%.
   - Convolutional layer, 32 feature maps with a size of 3×3 and a rectifier activation function.
   - Max Pool layer with size 2×2.
   - Convolutional layer, 64 feature maps with a size of 3×3 and a rectifier activation function.
   - Dropout layer at 20%.
   - Convolutional layer, 64 feature maps with a size of 3×3 and a rectifier activation function.
   - Max Pool layer with size 2×2.
   - Convolutional layer, 128 feature maps with a size of 3×3 and a rectifier activation function.
   - Dropout layer at 20%.
   - Convolutional layer,128 feature maps with a size of 3×3 and a rectifier activation function.
   - Max Pool layer with size 2×2.
   - Flatten layer.
   - Dropout layer at 20%.
   - Fully connected layer with 1024 units and a rectifier activation function.
   - Dropout layer at 20%.
   - Fully connected layer with 512 units and a rectifier activation function.
   - Dropout layer at 20%.
   - Fully connected output layer with 10 units and a Softmax activation function

     Did the performance change?

Ans

1.Created the model with the given specification..
2.Compiled the model.
3. Fit the training data into the model.
4. Evaluated the model.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Python 3 (ipykernel)
Run
Code
In [14]:
import numpy as np
from keras.datasets import cifar10
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten
from keras.layers.convolutional import Conv2D, MaxPooling2D
from keras.constraints import maxnorm
from keras.utils import np_utils
from keras.optimizers import SGD
# Fix random seed for reproducibility
np.random.seed(7)
# Load data
(X_train, y_train), (X_test, y_test) = cifar10.load_data()
# Normalize inputs from 0-255 to 0.0-1.0
X_train = X_train.astype('float32') / 255.0
X_test = X_test.astype('float32') / 255.0
# One hot encode outputs
y_train = np_utils.to_categorical(y_train)
y_test = np_utils.to_categorical(y_test)
num_classes = y_test.shape[1]
# Create the model
model = Sequential()
model.add(Conv2D(32, (3, 3), input_shape=(32, 32, 3), padding='same', activation='relu', kernel_constraint=maxnorm(3)))
model.add(Dropout(0.2))
model.add(Conv2D(32, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
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Earn...
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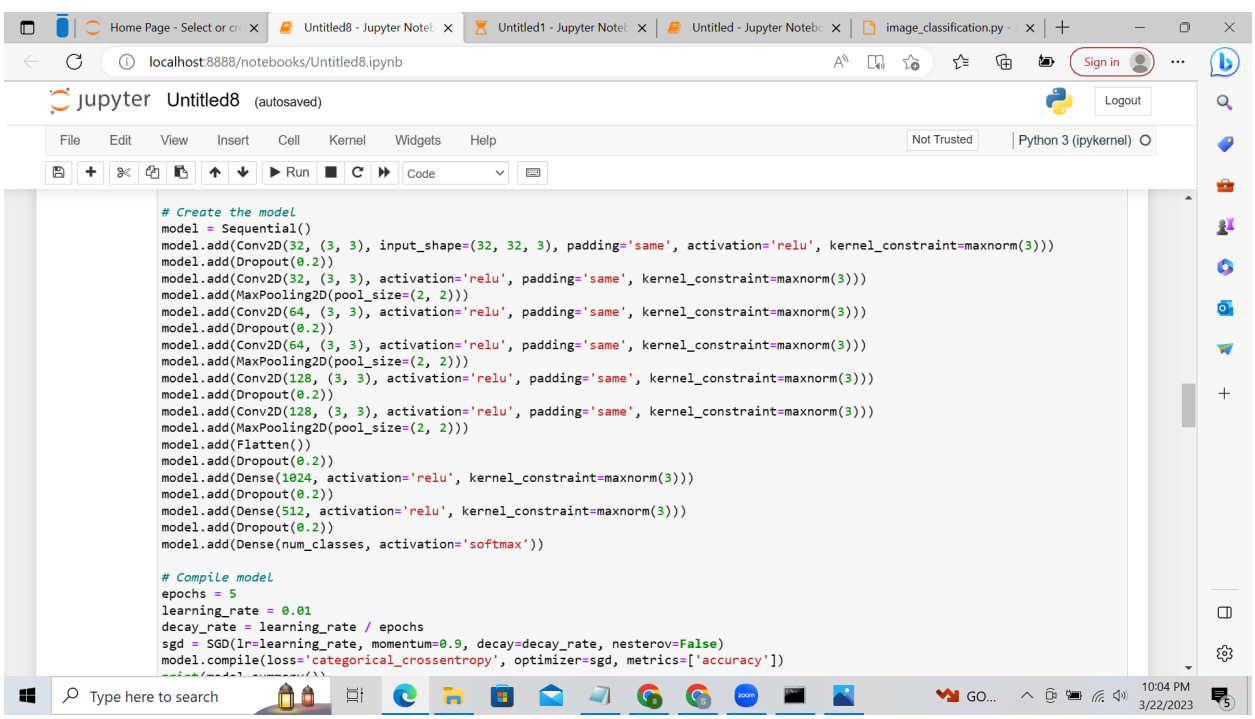
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model.add(Dropout(0.2))
model.add(Conv2D(32, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(64, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
model.add(Dropout(0.2))
model.add(Conv2D(64, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(128, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
model.add(Dropout(0.2))
model.add(Conv2D(128, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Flatten())
model.add(Dropout(0.2))
model.add(Dense(1024, activation='relu', kernel_constraint=maxnorm(3)))
model.add(Dropout(0.2))
model.add(Dense(512, activation='relu', kernel_constraint=maxnorm(3)))
model.add(Dropout(0.2))
model.add(Dense(num_classes, activation='softmax'))
# Compile model
epochs = 5
learning_rate = 0.01
decay_rate = learning_rate / epochs
sgd = SGD(lr=learning_rate, momentum=0.9, decay=decay_rate, nesterov=False)
model.compile(loss='categorical_crossentropy', optimizer=sgd, metrics=['accuracy'])
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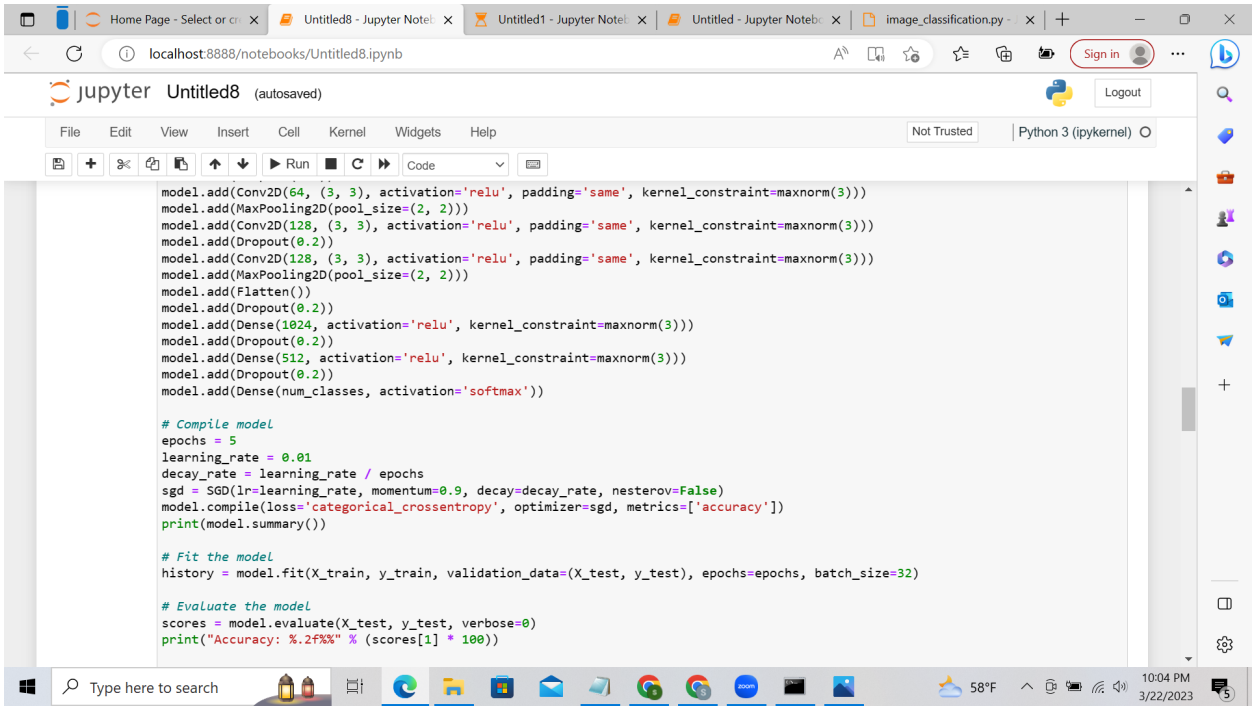
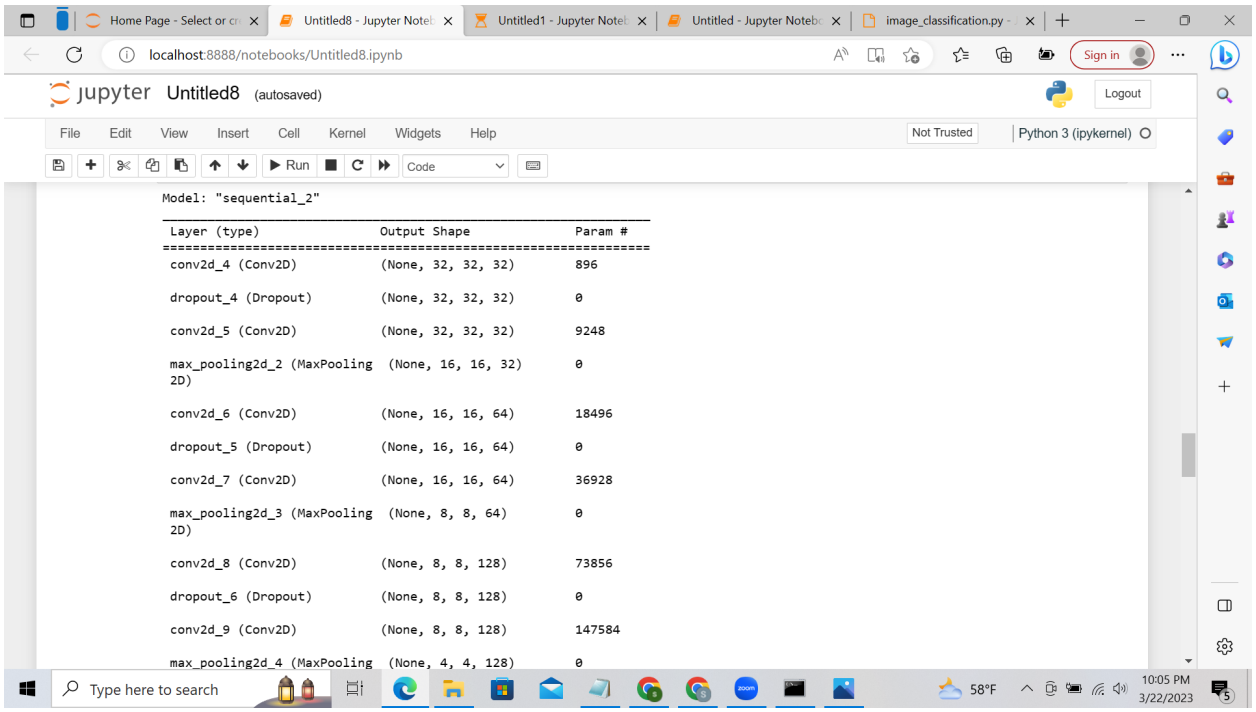
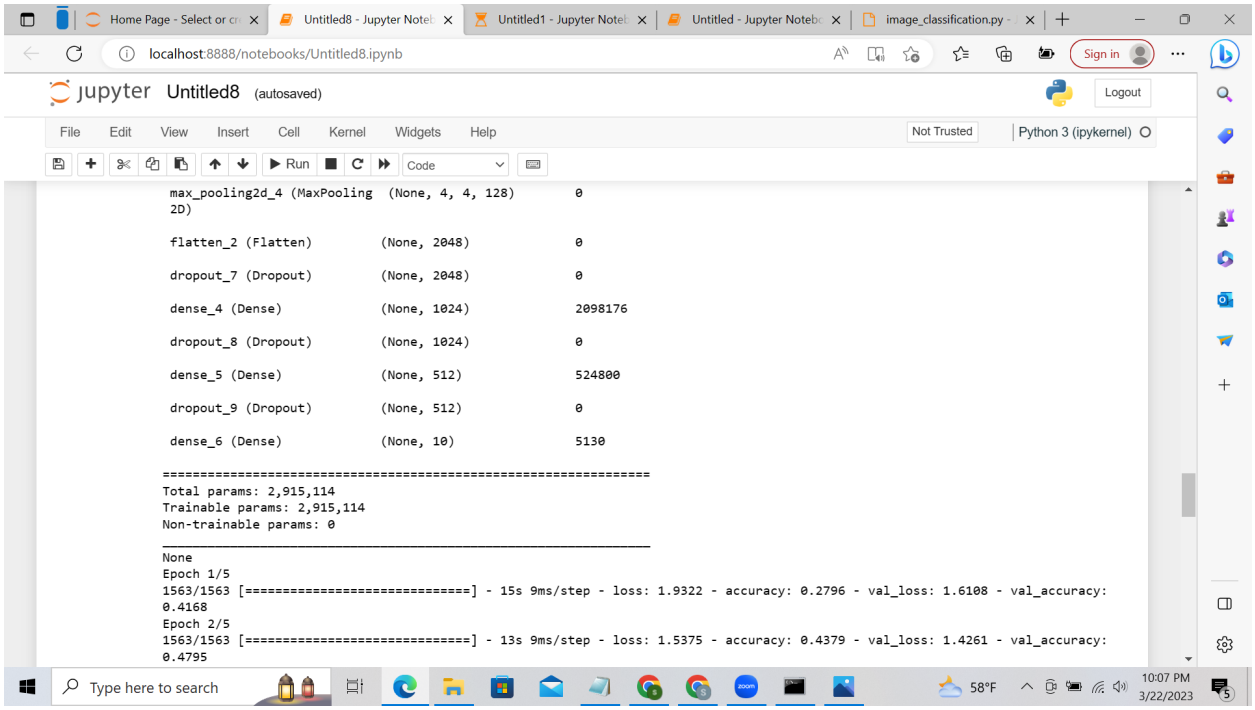


```
model.add(Conv2D(64, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(128, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
model.add(Dropout(0.2))
model.add(Conv2D(128, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Flatten())
model.add(Dropout(0.2))
model.add(Dense(1024, activation='relu', kernel_constraint=maxnorm(3)))
model.add(Dropout(0.2))
model.add(Dense(512, activation='relu', kernel_constraint=maxnorm(3)))
model.add(Dropout(0.2))
model.add(Dense(num_classes, activation='softmax'))

# Compile model
epochs = 5
learning_rate = 0.01
decay_rate = learning_rate / epochs
sgd = SGD(lr=learning_rate, momentum=0.9, decay=decay_rate, nesterov=False)
model.compile(loss='categorical_crossentropy', optimizer=sgd, metrics=['accuracy'])
print(model.summary())

# Fit the model
history = model.fit(X_train, y_train, validation_data=(X_test, y_test), epochs=epochs, batch_size=32)

# Evaluate the model
scores = model.evaluate(X_test, y_test, verbose=0)
print("Accuracy: %.2f%%" % (scores[1] * 100))
```

Output for the above code is



```
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_4 (Conv2D)           (None, 32, 32, 32)        896

 dropout_4 (Dropout)         (None, 32, 32, 32)        0

 conv2d_5 (Conv2D)           (None, 32, 32, 32)        9248

 max_pooling2d_2 (MaxPooling  (None, 16, 16, 32)       0
 2D)

 conv2d_6 (Conv2D)           (None, 16, 16, 64)        18496

 dropout_5 (Dropout)         (None, 16, 16, 64)        0

 conv2d_7 (Conv2D)           (None, 16, 16, 64)        36928

 max_pooling2d_3 (MaxPooling  (None, 8, 8, 64)         0
 2D)

 conv2d_8 (Conv2D)           (None, 8, 8, 128)         73856

 dropout_6 (Dropout)         (None, 8, 8, 128)         0

 conv2d_9 (Conv2D)           (None, 8, 8, 128)         147584

 max_pooling2d_4 (MaxPooling  (None, 4, 4, 128)        0
```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max_pooling2d_4 (MaxPooling 2D) (None, 4, 4, 128) 0
flatten_2 (Flatten) (None, 2048) 0
dropout_7 (Dropout) (None, 2048) 0
dense_4 (Dense) (None, 1024) 2098176
dropout_8 (Dropout) (None, 1024) 0
dense_5 (Dense) (None, 512) 524800
dropout_9 (Dropout) (None, 512) 0
dense_6 (Dense) (None, 10) 5130
Total params: 2,915,114
Trainable params: 2,915,114
Non-trainable params: 0
None
Epoch 1/5
1563/1563 [==========] - 15s 9ms/step - loss: 1.9322 - accuracy: 0.2796 - val_loss: 1.6108 - val_accuracy: 0.4168
Epoch 2/5
1563/1563 [==========] - 13s 9ms/step - loss: 1.5375 - accuracy: 0.4379 - val_loss: 1.4261 - val_accuracy: 0.4795
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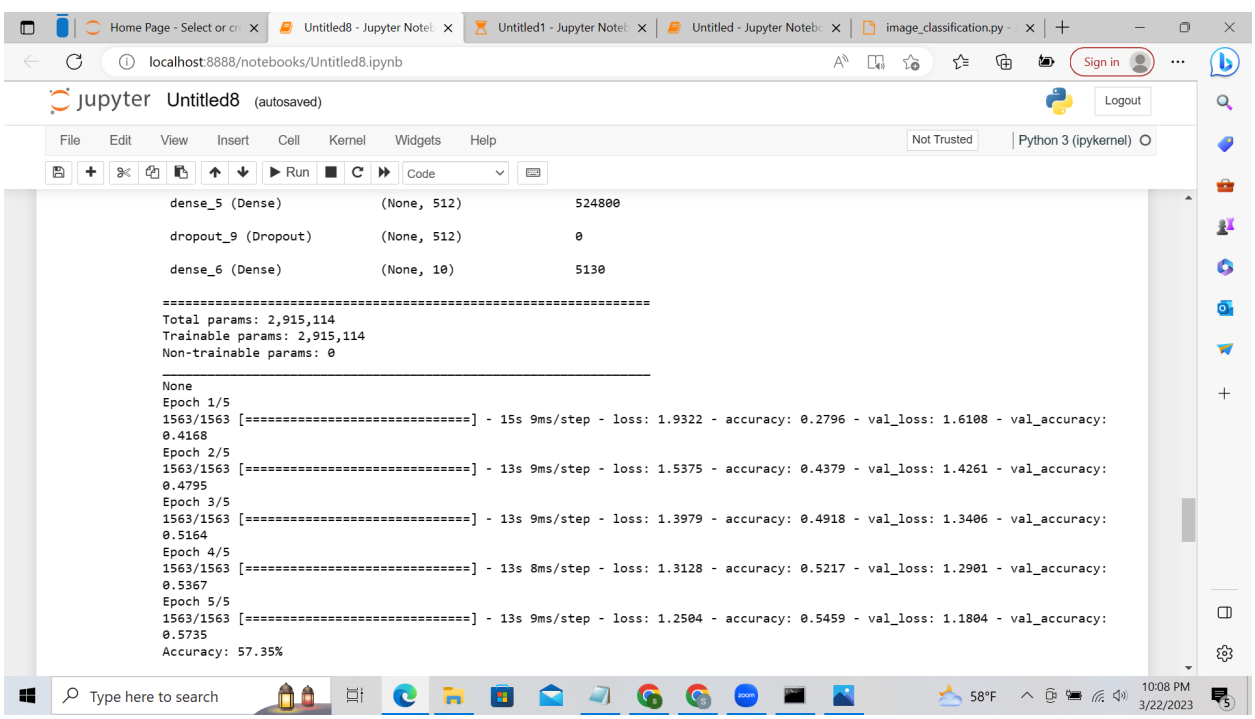
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Python 3 (ipykernel)
Run
Code
dense_5 (Dense) (None, 512) 524800
dropout_9 (Dropout) (None, 512) 0
dense_6 (Dense) (None, 10) 5130
Total params: 2,915,114
Trainable params: 2,915,114
Non-trainable params: 0
None
Epoch 1/5
1563/1563 [==========] - 15s 9ms/step - loss: 1.9322 - accuracy: 0.2796 - val_loss: 1.6108 - val_accuracy: 0.4168
Epoch 2/5
1563/1563 [==========] - 13s 9ms/step - loss: 1.5375 - accuracy: 0.4379 - val_loss: 1.4261 - val_accuracy: 0.4795
Epoch 3/5
1563/1563 [==========] - 13s 9ms/step - loss: 1.3979 - accuracy: 0.4918 - val_loss: 1.3406 - val_accuracy: 0.5164
Epoch 4/5
1563/1563 [==========] - 13s 8ms/step - loss: 1.3128 - accuracy: 0.5217 - val_loss: 1.2901 - val_accuracy: 0.5367
Epoch 5/5
1563/1563 [==========] - 13s 9ms/step - loss: 1.2504 - accuracy: 0.5459 - val_loss: 1.1804 - val_accuracy: 0.5735
Accuracy: 57.35%
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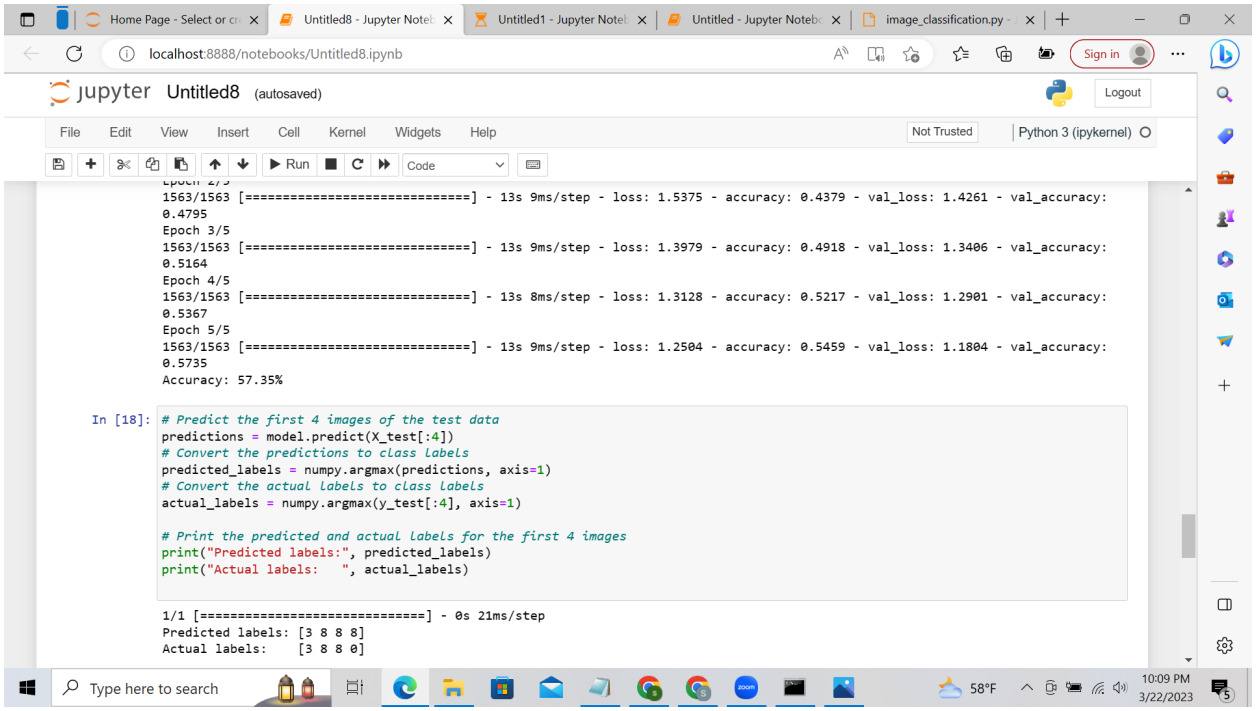
2. Predict the first 4 images of the test data using the above model. Then, compare with the actual label for those 4 images to check whether or not the model has predicted correctly.
Ans

1. Predicted the first 4 images of the test data using the above model.
2. Converted the predictions to class labels
3. Converted the actual labels to class labels.
4. Printed the Predicted labels and actual labels.



3. Visualize Loss and Accuracy using the history object
Ans:
1.Visualized the Loss and Accuracy using the history object.

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In [19]:
```
import matplotlib.pyplot as plt

# Plot the training and validation loss
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('Model Loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['train', 'val'], loc='upper right')
plt.show()

# Plot the training and validation accuracy
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['train', 'val'], loc='lower right')
plt.show()
```

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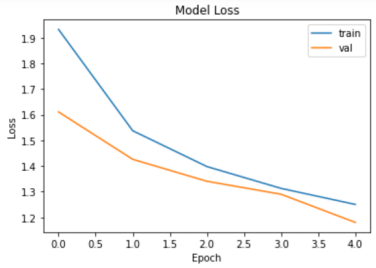

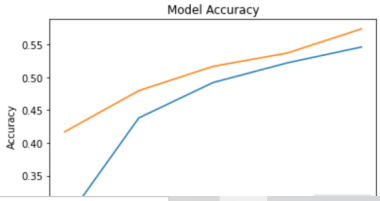

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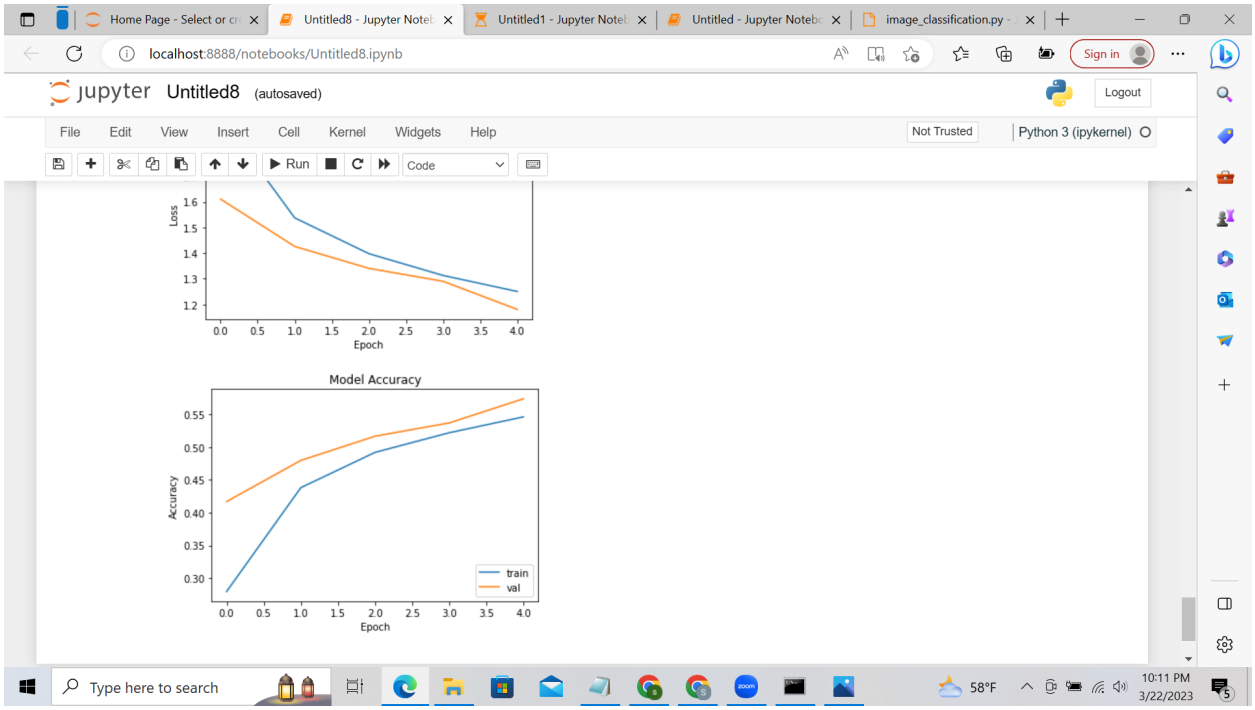
Loss
Epoch
Model Accuracy
Accuracy
Epoch
train
val